

AMENDED CLAIMS

[received by the International Bureau on 22 December 2004 (22.12.04);
original claims 1-25 are replaced by amended claims 1-24]

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1. A method of die bonding comprising the steps of: providing a structure (10) comprising a wafer substrate (11) separated from carrier base means (13) by an adhesive layer (12) adhered to the carrier base means by a first adhesive; laser machining through the wafer substrate and through the adhesive layer no more than at most to scribe the carrier base means to form a singulated die (15) with an attached singulated adhesive layer (12); curing the structure to release the attached singulated adhesive layer from the carrier base means by curing the first adhesive; picking and placing the die and attached singulated adhesive layer on a die pad; and curing the attached singulated adhesive layer to adhere the die to the die pad.
2. A method as claimed in claim 1, wherein the step of laser machining comprises laser machining the wafer substrate (11) using a first laser beam (31) with a first machining profile of selected laser pulse power, laser pulse repetition rate, laser pulse width, laser beam scanning speed and laser wavelength; using a second laser beam (32) with a second such machining profile to machine the adhesive layer (12) and using a third laser beam (33) with a third such machining profile to machine the carrier base means (14) such that a speed of machining is maximised while providing a predetermined quality of singulated dies without substantial delamination of the adhesive layer and the carrier base means or substantial production of burrs.
3. A method as claimed in claim 2, wherein at least two of the first machining profile, the second machining profile and the third machining profile are a same machining profile.
4. A method as claimed in any of the preceding claims, wherein the step of curing the structure (10) comprises curing with ultraviolet light.
5. A method as claimed in any of the preceding claims, wherein the step of curing the attached singulated adhesive layer (12) comprises heat curing the adhesive layer.
6. A method as claimed in any of the preceding claims, wherein the step of machining the wafer substrate comprises machining a blind via (14) in

the wafer substrate (11) or a via through the wafer substrate (11) and a die attach film (12).

7. A method as claimed in any of the preceding claims, wherein the step of laser machining includes a further step, after laser machining, of washing the structure to remove accumulated laser machining debris from the singulated die (15).
8. A method as claimed in claim 7, wherein the step of providing a structure comprises providing a structure having a protective film to protect the structure from debris produced during laser machining and the step of washing the structure comprises removing the protective film and accumulated debris thereon.
9. A method as claimed in any of the preceding claims, wherein the step of providing a structure comprises providing a structure having a wafer substrate (11) less than 800 microns thick.
10. A method as claimed in any of the preceding claims, wherein the step of laser machining comprises providing an assist gas environment for laser machining.
11. A method as claimed in claim 10, wherein the step of providing an assist gas environment comprises providing a gas environment in which photo-dissociation produces active radicals.
12. A method as claimed in claims 10 or 11, wherein the step of providing a gas environment reduces deposition of solid machining debris around a laser-machining site.
13. A method as claimed in any of the preceding claims, wherein the carrier base means is one of: a dicing tape, an inflexible tape suitable for thin wafer dicing or backgrinding; and a glass or other transparent solid.
14. A method as claimed in any of the preceding claims, wherein the step of providing a structure comprises providing a structure including a wafer substrate separated facedown from substantially inflexible transparent backgrinding tape means by the adhesive layer and the step of laser machining is performed subsequent to backgrinding the wafer substrate.

15. A method as claimed in any of the preceding claims, wherein the step of picking and placing the die and attached singulated adhesive layer comprises picking and placing the die and attached singulated adhesive layer on another die to form a multistack die package.
16. A die bonding apparatus comprising: laser machining means arranged for machining a wafer substrate (11) and an adhesive layer attached (12) to the wafer substrate and for no more than at most scribing underlying carrier base means (13) to form a singulated die with a singulated adhesive layer (15); first curing means arranged for curing the carrier base means to release the singulated adhesive layer (12) from the carrier base means (13); pick and place means arranged for picking the singulated die and adhesive layer (15) from the carrier base means (13) and placing the singulated die and adhesive layer (15) on die pad means and second curing means arranged for curing the singulated adhesive layer (12) of the singulated die to adhere the singulated die to the die pad means.
17. A die bonding apparatus as claimed in claim 16, wherein the laser machining means comprises: laser source means arranged for providing a pulsed laser beam (31, 32, 33); laser beam scanning means; and control means arranged for controlling at least one of laser pulse energy, laser wavelength, laser repetition frequency, laser pulse width, laser beam scanning speed and a number of scans by the pulsed laser beam.
18. A die bonding apparatus as claimed in claim 17, wherein the laser machining means further comprises memory means for storing a machining profile of at least one of laser pulse energy, laser wavelength, laser repetition frequency, laser pulse width, laser beam scanning speed and a number of scans by the pulsed laser beam, for use by the control means.
19. A die bonding apparatus as claimed in any of claims 16 to 18, wherein the first curing means comprises ultraviolet curing means.
20. A die bonding apparatus as claimed in any of claims 16 to 19, wherein the second curing means comprises heat curing means.

21. A die bonding apparatus as claimed in any of claims 16 to 20, including washing means arranged for washing laser machining debris from the singulated die.
22. A die bonding apparatus as claimed in claim 21, wherein the wafer substrate is provided with a protective film to protect the wafer substrate from laser machining debris, and the washing means is arranged to remove the protective film from the singulated die.
23. A die bonding apparatus as claimed in any claims 16 to 22, adapted for carrier base means which is one of: a dicing tape, an inflexible tape suitable for thin wafer dicing or backgrinding; and a glass or other transparent solid.
24. A die bonding apparatus as claimed in any claims 16 to 22, adapted for machining a structure comprising a wafer substrate separated facedown from substantially inflexible transparent backgrinding tape means by the adhesive layer.